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ABSTRACT

The main objective of this study was to design an instrument to assess the value preferences of college non-science majors with respect to certain aspects of environmental chemistry. A second objective was to obtain measures of the value preferences of various groups of non-science majors who had completed some chemistry courses. The early construction of the instrument and the format was based on pilot studies performed by the authors. Validity and reliability measures were determined. Nine findings were noted. The overall results suggest that since non-science majors have a strong value preference for the humanistic aspects of chemistry with regard to environmental problems, then curriculum designers, textbook writers, and course instructors should structure their course activities toward these strong value preferences. (LS)

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An Assessment of Value Preferences
of College Students with Reference
to Environmental Chemistry

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Introduction

In very recent years, science educators have worked toward the development of curricular courses and programs stressing the relevancy of science with respect to our environmental problems. Cook (1971) contends that chemistry instruction should reflect social concern. "We must approach the student, the citizen, the public decision maker on his terms. . . . we may have to humanize it a bit." Schwab (1974) presents a strong argument for the coming duty of science teaching that is to impart competencies and attitudes; competencies to inquire and the development of attitudes and values concerning the interpretation of evidence, argument, certainty and uncertainty. Schwab contends that the natural sciences, the social studies, and the humanities in the schools should allow time in an interdisciplinary way for the treatment of practical problems. Schwartz (1974) in a provocative opinion further supports the notion that the bridge between the sciences and the humanities can be based upon the intellectual content of chemistry and its usefulness. There are now currently several college-level chemistry textbooks written for the non-science majors which attempt to relate and to explain the chemical bases of our environmental problems. There appears to be a strong emotional or affective interest on the part of students when investigating this environmental problem. A recent exploratory study by Fazio (1974) revealed that college students' responses to environmental catastrophes reflect their serious concerns over the humanistic implications of the problems as well as their

relationships to industry, technology and government. Student responses seemed to be overwhelmingly affective and interdisciplinary and with a strong reflection of their value systems. Attitudes and values are very important objectives in any environmental education program. Knapp (1972) states that values are considered to be desirable standards which influence peoples' activities. "Attitudes and values in environmental education hold the keys to the future of mankind and the quality of life on this planet."

Purpose

The main objective of this study was to design an instrument to assess the value preferences of college non-science majors with respect to certain aspects of environmental chemistry. The second purpose of this investigation was to use the instrument to obtain measures of the value preferences of various groups of non-science majors who had completed some chemistry courses. Additional assessments were made of the value preferences of science majors as well as high school chemistry teachers in service. The authors felt that the instrument and the value assessments obtained may be useful for science educators in formulating objectives and teaching strategies that reflect the values of their students.

The Instrument

The findings of the Fazio study (1974) along with the earlier work by Huston (1972) prompted these authors to conduct pilot studies to detect any general patterns of value preferences. The students were asked to

respond in free written form to certain serious environmental problems. The analyses of the written protocols indicated three general value preferences. These three preferences were defined and established as operational constructs. They were Humanistic value preference; Theoretical value preference, and Technology value preference. A humanistic preference was one which placed value on the relationship to man, to society, to the welfare of the world and/or of living things. The theoretical preference was a value for the chemical principles, facts and/or concepts. The technological preference was one where value was placed on industrial use and practical wide-spread applications in industry and the economy.

The chemistry value preference instrument consisted of 28 sets of statements. Each set began with a simple statement or a phrase related in some way to environmental chemistry. This was followed by three alternative choices: one stressing the humanistic, one the theoretical, and another the technological aspects of the chemical phenomena or facts (see appendix).

The validity of the instrument was established with reference to the defined value constructs for humanistic, theoretical, and technological and the content validity was further established with reference to the judgement of three college chemistry professors as well as two science educators. The content reference to environmental chemistry was judged to be of a very general nature. The value preferences were agreed upon as to the definitions in the operational constructs.

The reliability measures were determined using the Kuder-Richardson formula 20, and were based upon the data from two separate groups of non-science majors.

TABLE 1

Reliability of Environmental Chemistry Value Preference Instrument

KR-20

	Physical Science N=131	Health Services Majors N=49
Humanistic	0.82	0.86
Theory	0.88	0.91
Technological	0.59	0.63

The reliability of the test scores were consistently high as indicated in Table 1.

Procedure

The student sample data sources consisted of those non-science majors enrolled in a physical science course based upon environmental problems, as well as the health services majors (physical education majors, nursing majors) who had just completed a chemistry course. A group of junior-level elementary education majors who had just completed a science content-methods survey course was also included. For comparisons, a group of junior-senior chemistry majors and a small group of junior-senior biology majors were included in the data. A sample of 19 high school chemistry teachers from Western Pennsylvania were also administered the test instrument. The testing time was approximately 20-30 minutes. The data summaries of all groups who took the ECVP instrument are listed in Table 3.

Findings

Since three separate value preference scores were obtained from the test instrument, a one-way analysis of variance was conducted for

the physical science group in order to determine if the three scores were significantly different from each other. The results are summarized in Table 2. The three value scores were found to be significantly different. Post-hoc comparisons indicated that Humanistic value preference score was significantly greater than the Theory preference and the Technology preference scores. The Technology value preference was significantly greater than the Theory preference score. The same pattern and trend of results were found for the health services group of students. The elementary education majors value preference pattern was found to be the same as the above two groups.

A series of planned comparisons were conducted to answer specific questions concerning the value preferences of non-science majors compared with science majors.

The highest Theory value preferences were recorded by the science majors (chemistry, biology and the high school chemistry teachers). These high Theory scores were significantly different than the theory scores of non-science major groups. The non-science majors groups had significantly higher Humanistic value preference scores than the majors groups. There were no significant differences in the Technology value scores of the chemistry majors and non-science majors.

The biology majors had significantly lower Technology value scores as compared with any of the other groups. The chemistry majors and the high school chemistry teachers were not significantly different in any of their mean value scores. The biology majors were not significantly different from the chemistry groups with respect to their mean Theory and Humanistic value scores.

Table 2

Analysis of Variance* of the Three Mean Value Preference Scores for the Physical Science Students N=131

Source	DF	Sums of Squares	Mean Square	F-Ratio	Probability
Category Means	2	60884.5	30442.3	414.1	0.0000
Within	390	28668.9	73.5		
Total	392	89553.4			

Table 3

Means and Standard Deviations of the Various Groups' Value Preference Scores

		Theory	Humanistic	Technology
Physical Science	$\bar{X}$	13.50	43.88	26.48
N=131	S.D.	10.97	7.73	6.35
Health Services	$\bar{X}$	16.63	39.65	27.61
N=49	S.D.	12.34	9.64	5.74
Elem. Education	$\bar{X}$	19.31	36.40	28.34
N=32	S.D.	10.83	9.99	6.08
Chemistry Majors	$\bar{X}$	25.50	32.65	25.85
N=26	S.D.	11.39	11.47	8.08
Chemistry Teachers	$\bar{X}$	27.89	31.84	24.26
N=19	S.D.	17.39	12.57	8.83
Biology Majors	$\bar{X}$	30.44	34.63	18.81
N=16	S.D.	16.43	12.21	7.95

*Xerox Sigma-6 Computer- Vanderbilt Statistical Package, Indiana University of Pennsylvania Computer Science Library, 1975.

To answer the question of whether there are any sex differences in value preferences, the two largest groups were sorted into sex categories and t-tests were conducted. Table 4 summarizes the data. Generally there were no significant differences in the value preference scores of males and females. The males in the Health Services had significantly higher Technology scores than the females. Table 5 summarizes the correlations of the three values preferences and the course letter grade for the non-science majors who were enrolled in the environmental problems physical science course. There were no significant correlations between any of the three value preference scores and the course letter grade. The Humanistic and Technology value scores were found to be significantly negatively correlated with the Theory scores.

Table 4

Value Preference Scores According to Sex

Physical Science	Theory		Humanistic		Technology	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Males N=65	13.05	9.97	44.27	7.84	26.50	6.05
Females N=66	13.97	11.97	43.49	7.66	26.48	6.68
Health Services	$\bar{X}$	S.S.	$\bar{X}$	S.D.	$\bar{X}$*	S.D.
Males N=17	15.06	12.52	38.76	9.20	30.18	6.59
Females N=32	17.47	12.37	40.13	9.98	26.25	4.81

*Significant at .02

Table. 5

Correlation Matrix of Three Value Scores
Versus Course Letter Grade

Physical Science Group N=131

	Theory	Humanistic	Technology	Course Grade
Theory	-	-.820	-.731	0.011
Humanistic	-	-	.218	0.021
Technology	-	-	-	-0.045
Course Grade	-	-	-	-

Summary

On the basis of the validity and the reliability data as well as the data collected with the instrument, it is proposed that the Environmental Chemistry Value Preference instrument (ECVP) is a valid, reliable, and reasonably efficient way of assessing the value preferences of college students with respect to the chemical basis of some of our environmental problems.

The overall results strongly suggest that non-science majors have a strong value preference for the Humanistic aspects of chemistry with regards to environmental problems. Their overall low value preference for Theory might indicate either disregard for theory or an ignorance of the theory behind the chemical bases of our environmental problems. It is also worthy to note that the science majors also had their highest scores in the Humanistic Value preference. The Technology Value preference is also worthy of consideration. Overall the groups were not

different in their <u>Technology</u> scores.

The authors feel that the evidence gathered in this investigation provide strong support for the notion that the humanistic aspects of chemistry should be incorporated into course objectives. Curriculum designers, textbook writers, and course instructors should work toward structuring their course activities towards these strong <u>Humanistic</u> value preferences. The authors feel that the results suggest a need for a more meaningful structuring and the relating of the theoretical concepts to the humanistic and the technological aspects of our environmental problems.

Suggestions for Further Research

The value preference instrument needs to be tested with larger groups, especially with the science majors and high school teachers. A more thorough item analysis might be helpful to instructors to assess specific areas where their students might need more theoretical background. The instrument might be refined in future investigations by asking students to give a reason for their choice to each set. This free written response by the student might provide additional value and/or attitudinal information.

Appendix

Environmental Chemistry Preference Evaluation Instrument

2. D.D.T.

   A. is a pesticide that has been found to be spread world-wide and is a potential threat to living things.

   B. is chemically known as dichlorodiphenyl trichloroethane, a chemically stable chlorinated hydrocarbon.

   C. is a quite universal pesticide that has helped increase agricultural yield and is a credit to American scientific technology.

3. Sulfur dioxide gas can react with water vapor in the air

   A. sulfur dioxide and related products have been found to be serious air pollutants with harmful effects to people and property.

   B. sulfur dioxide gas is a by-product of several industrial processes namely the burning of fossil fuels.

   C. is chemically written as $SO_2 + H_2O \longrightarrow H_2SO_3$, the product is the acid known as sulfurous.

10. Modern synthetic detergents

    A. are the results of modern chemical technology, using a variety of substances to produce an inexpensive and efficient product.

    B. consist of a mixture of surfactant molecule, a phosphate builder to reduce hard water ions and a variety of other additives.

    C. parts of certain detergents are not decomposeable with the result, that our drinking water may be foamy in appearance.

13. Uranium--235 and plutonium--239 are fissionable.

    A. nuclear power plants use these fissionable isotopes as fuel.

    B. these isotopes are fissioned by neutrons, with the release of more neutrons and a resulting sustained chain reaction.

    C. highly radioactive fission, careless storage and waste disposal of the fragments can pose a serious threat to mankind.

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